

REMARKS

This amendment is filed in response to the Office Action dated September 24, 2003. Applicant submits that this application should be allowed and the case passed to issue.

No new matter is raised by this amendment. The amendment to claim 1 is supported by the specification at page 11, lines 10-14. Amended claim 5 is supported by claim 1 and page 11, lines 10-14 of the specification. The amendment to claim 10 is supported by claim 7. New claims 15-18 are supported by Figures 1, 2, 14, 17, and 22.

Claims 1-18 are pending in this application. Claims 1-6, 10-12, and 14 are rejected. Claims 7-9 and 13 have been allowed. Claims 15-18 are newly added.

Interview Summary

Examiner Loke is thanked for the courtesy of granting a personal interview with the undersigned on December 18, 2003. During the interview, the undersigned asserted that the specification supports claim 1. While, the Examiner agreed that the position of the interface in a depth direction changes in the direction of crossing the direction of current flow, as taught on page 13, lines 25-33, and Fig. 15, Examiner Loke maintained that there is no support in the specification for a position of an interface in the depth direction that changes for any cross sections along a direction of flow of the current. Examiner Loke pointed out that Fig. 14 illustrates that the lower interface between the fourth region 7 and the first region 2 is flat along the direction of current flow. The Examiner asserted that the interface appeared to be wave-shaped rather than bowl-shaped, thus the position of the interface would only change in the direction orthogonal to the current flow and not along the direction of the current flow.

Claim Rejections Under 35 U.S.C. § 112

Claims 1-6, 12, and 14 are rejected under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement. This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner asserts that specification does not convey to one of skill in this art that the inventors had possession of the claimed invention at the time the application was filed. The Examiner characterizes FIG. 14 as disclosing a position of an interface between p-type region 7 and n-type region 2 in a depth direction is constant along a direction of flow of the current from the n-type regions 6a-6d to the n-type region 4. Therefore, the Examiner avers that the specification does not disclose that a position of an interface between the first region and the fourth region in a depth direction changes for any cross sections crossing a region in which the interface exists along a direction of the flow of the current. The Examiner also asserts that, although, FIG. 14 and 15 disclose the position of the interface in the depth direction changes for a cross section crossing the region along a direction substantially orthogonal to the direction of the current flow, the specification does not disclose the position of the interface between the first region and the fourth region in a depth direction changes for any cross sections crossing the region along a directions substantially orthogonal to the direction of the current flow. The Examiner further avers that the specification does not discloses a plurality of fourth regions spaced from each other by a distance allowing connection between depletion layers extending from the neighboring fourth regions, respectively, in an on state, as required by claim 5.

In order to advance the prosecution of this application, claim 1 has been amended to delete the limitation that a position of an interface between the first and fourth regions in a depth direction changes for any cross sections crossing a region in which the interface exists along a

direction of the flow of the current. Thus, the rejection under 35 U.S.C. § 112 that the specification did not support this limitation is moot. The specification expressly teaches that “the depth of P-type diffusion region 7 changes as the position moves in the direction crossing the direction of the current flow, as shown in Fig. 15” (page 13, lines 25-27). Therefore, this rejection should be withdrawn.

Claim 5 has been rewritten in independent form. Figures 1-3 and 17, and page 10, lines 1-4 of the specification clearly teach a plurality of fourth regions spaced from each other by a distance allowing connection between depletion layers extending from the neighboring fourth regions in an on state.

Applicant submits that independent claims 1 and 5 fully comport with the requirements of 35 U.S.C. § 112 and are distinguishable over the cited prior art. Kitamura describe that a depletion layer extends in the first region (n region 2) sandwiched between the semiconductor substrate (p substrate 1) and the fourth region (p diffusion layer 4) in an off state to attain a pinch off state (column 9, lines 18-45). In the present invention, however, as shown in FIG. 2, depletion layers A, B extend in the first region 2 in an on state. The depletion layers are formed such that they differ in position (depth) of the ends thereof so as to guarantee the current flow and to suppress the resistance in the on state. As a result, the present invention does not perform a pinch-off operation in which the first region 1 would be entirely depleted to suppress the current flow. The first region 2 has a region, located directly beneath the depletion layer B, that is not depleted by the depletion layer B which extends from the fourth region 7 in the on state, as show in Figs. 2 and 3. The sixth region 3 of the present invention, having an impurity concentration that is higher than that of the first region 2 and extending toward the first region,

prevents the depletion layer from extending toward the substrate. The sixth region, which has a higher impurity concentration, can also restrict the resistance in the on state.

The sixth region, according to the present invention, suppresses the extension of the depletion layer, and thus enables the setting of the voltage of the element independent from the potential of the semiconductor substrate. In contrast thereto, the voltage of the Kitamura element depends on the potential of the semiconductor substrate because the depletion layer extends over the first region to attain the pinch-off state.

Furthermore, in Kitamura, the depletion of the fourth region 4 is such that the withstand voltage is not restricted between the n⁺ diffusion layer 9 and the p-diffusion layer fourth region 4 in an off state. In addition, the fourth region 4 is required to be electrically connected to the electrode 12a to ensure stability of the pinch-off operation. In the present invention, in contrast to Kitamura, the extension of the depletion layer relaxes the electric field, so that the fourth region is allowed to function sufficiently even if it is in an electrically floating state. Thus, the fourth region is spaced apart from the third region.

Claims 10 and 11 are rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner maintains that claim 7 discloses a single fourth region and asserts that it is unclear how a plurality of discretely formed regions are able to have a depth changing as a position moves in a direction crossing a direction of flow of the current as in claim 10.

Claim 10 has been rewritten in independent form. As explained above as regards claims 1 and 5, the specification clearly discloses a plurality of discretely formed regions having a depth changing as a position moves in a direction crossing the flow of current.

Applicants submit that the dependent claims, including newly added claims 15-18, are allowable for at least the same reasons as the respective independent claims from which they depend, and further distinguish the claimed invention.

Allowable Subject Matter


Claims 7-9 and 13 are allowed. Applicant gratefully acknowledges the indication of allowable subject matter.

In light of the amendment and remarks above, this application should be allowed and the case should be passed to issue. If there are any question regarding this Amendment or the application in general, a telephone call to the undersigned would be appreciated to expedite the prosecution of the application.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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